

WHAT IS CLAIMED IS:

1. A method for forming a (111) oriented crystalline dielectric layer comprising:
 - forming a first capacitor electrode layer on a substrate;
 - exposing the substrate to a first gas that includes material to form the dielectric layer at a first temperature; and
 - exposing the substrate to a second gas that includes material to form the dielectric layer at a second temperature, wherein the second temperature is higher than the first temperature, wherein a (111) oriented crystalline dielectric layer is formed.
2. The method of claim 1, wherein the first gas includes material that forms an oxide or titanate.
3. The method of claim 1, wherein the first and second gas are the same.
4. The method of claim 1, wherein the first and second gas comprise barium, strontium, titanium, and oxygen.
5. The method of claim 4, wherein the first electrode comprises a (111) oriented conductor.
6. The method of claim 5, wherein the first temperature is less than about 500 degrees Celsius and greater than or equal to about 430 degrees Celsius.
7. The method of claim 5, wherein the duration of the exposure of the first gas at a first temperature is about 2 to 30 seconds.
8. The method of claim 5, wherein the second temperature is greater than about 600 degrees Celsius.

9. A method for forming a (111) oriented crystalline barium strontium titanium oxide layer with high capacitance comprising:

depositing a capacitor electrode layer on a substrate, wherein the electrode layer comprises a crystalline oriented film;

nucleating a seed layer for effecting a (111) orientation of the barium strontium titanium oxide (BSTO), wherein the substrate is exposed to a gas comprising a metal oxide at a first temperature; and

growing a continuous layer of (111) oriented barium strontium titanium oxide, wherein the substrate is exposed to a gas comprising barium, strontium, titanium, and oxygen at a second temperature.

10. The method of claim 9, further comprising preparing the metal surface before the step of nucleating a seed layer.

11. The method of claim 9, wherein the metal electrode comprises (111) oriented platinum.

12. The method of claim 10, wherein preparing the metal surface includes exposing the substrate to a third temperature for less than about 60 seconds.

13. The method of claim 11, wherein the gas used for nucleating a seed layer and the gas used for growing a continuous film are the same.

14. The method of claim 13, wherein the first temperature is less than about 500 degrees Celsius and greater than or equal to about 430 degrees Celsius.

15. The method of claim 13, wherein the duration of the exposure of the substrate to a gas comprising a metal oxide at a first temperature is about 2 to 30 seconds.

16. The method of claim 14, wherein the second temperature is greater than about 600 degrees Celsius.

17. The method of claim 16, wherein the first temperature is about 460 degrees Celsius.

18. The method of claim 17, wherein the continuous layer of (111) oriented barium strontium titanium oxide has a thickness of about 5 to 30 nanometers.

19. A method for growing a (111) oriented BSTO crystalline layer for use as a capacitor comprising:

forming a (111) oriented crystalline first electrode on a substrate;

heating the substrate to a temperature sufficient to render the electrode surface substantially clean, but less than that necessary to cause a degradation in the (111) crystalline orientation of the surface;

heating the substrate to a second temperature and exposing the substrate to a gas including the elements comprising a first metal oxide, wherein the second temperature is sufficiently high to form a plurality of crystalline seeds required to subsequently form the (111) oriented crystalline BSTO layer, and further wherein the second temperature is less than that necessary to cause a degradation in the degree of (111) crystalline orientation of the BSTO crystalline layer; and

heating the substrate to a third temperature and exposing the substrate to a gas including the elements comprising a second metal oxide, wherein the third temperature is sufficiently high to grow a (111) oriented crystalline BSTO layer from the crystalline seeds.

20. The method of claim 19, wherein the first metal oxide and second metal oxide are the same.